Sea-salt particles related to chemistry of atmospheric sulfur

While a breeze over the ocean may cool beach-goers in the summertime, a new scientific study has revealed that tiny wind-blown sea-salt particles drifting into the atmosphere participate in a chemical reaction that may have impacts on climate and acid rain.

The research, published in the July 3 online issue of *Science Express*, could have substantial implications for increasing the accuracy of climate models.

The study by scientists at the Department of Energy's Pacific Northwest National Laboratory and the University of California, Irvine, indicates that sea salt plays an important role — but one previously not well understood — in the chemistry of sulfur in the atmosphere. One form of sulfur — sulfur dioxide — is a byproduct of burning fossil fuels containing sulfur. Sulfer dioxide is also formed when naturally emitted sulfur-containing compounds react in the atmosphere. In the air, sulfur dioxide is converted to sulfuric acid, a major component of acid rain and a contributor to haze in the atmosphere. These haze particles can affect clouds, which play an important role in climate.

For years, climate experts have struggled to capture the effects of sulfur chemistry in climate models. The PNNL-UCI study provides a new understanding of sea salt's role in atmospheric chemistry that will allow scientists to better predict and capture that information in models used to predict climate change.

"Our studies indicate that sea-salt particles will absorb more sulfur dioxide and convert it to sulfuric acid more rapidly than previously thought," said Barbara Finlayson-Pitts, a professor of chemistry at UCI and a foremost expert on atmospheric chemistry who participated in the study while on sabbatical at PNNL. "The chemistry discovered in these experiments is not currently included in models of sulfuric-acid formation in air, but could help to resolve discrepancies between model predictions and measurements of sulfur dioxide and sulfuric acid, which is essential for understanding the role of these compounds in acid deposition and global climate."

The importance of sea salt shouldn't be underestimated, said Alexander Laskin, first author of the *Science Express* paper and senior research scientist at PNNL. With nearly three-quarters of the earth's surface covered by water, a considerable number of sea-salt particles enter the lower atmosphere and, given their minute size, can be carried long distances.

In the lab, the team of scientists simulated an ocean spray in which wind carries tiny sea-salt particles into the atmosphere. They then exposed the salt particles to three important elements found in the atmosphere — ozone, water vapor and light. The reaction caused the salt particles to change from neutral to basic.

"Climate modelers have assumed that the sea-salt particles rapidly become acidic in the atmosphere. Therefore, their impact on climate was underestimated," Laskin said. "We now know that, under certain conditions, they remain basic during the day and therefore their role must be reconsidered."

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The team went on to theorize that when the sea-salt particle is a base, it would be able to absorb substantial amounts of sulfur dioxide, and convert it to sulfuric acid in the particles.

" We're providing a new fundamental understanding of atmospheric chemistry that allows climate models to more accurately consider the role of sea salt in climate change," he said. "The basic chemistry is crucial to understand if we want to accurately predict warming on a regional or global scale."

In the experiments, the team used table salt rather than sea salt because it accounts for 90 percent of the compounds found in sea salt. They used a computer-controlled scanning electron microscope and time-of-flight secondary ion mass spectrometer housed in the William R. Wiley Environmental Molecular Sciences Laboratory.

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